Avena barbata Brot. (Poaceae)
Slender wild oat

Description. Annual, 3-6 (8) dm tall, erect, stems erect, glabrous to short-soft-hairy. Leaves alternate; ligules 1-4 mm long, lacerate, auricles absent; sheaths glabrous to pubescent; blades linear, flat, 1-5 mm wide, glabrous to soft-puberulent. Inflorescence an open terminal panicle, 3-10 cm long. Spikelets 20-30 mm long, slightly compressed, composed of 3-8 florets, the glumes linear to narrowly lanceolate, the lower one 5-10 mm long, 1-nerved, the upper one 8-13 mm long, 3-nerved; lemmas 12-17 mm long, lanceolate, 3-5-nerved, the back keeled to rounded, the apex with two lateral teeth 4-5 mm long, the back of the lemma with a bent awn l2-20 mm long. In California, flowering from March to June. (Arnow 1987, Hitchcock 1944, Holmgren and Holmgren 1977, Munz 1959, Rocha Afonso 1980, Wilken 1993).

Note: Originally believed derived from *A. fatua, A. harbata* most likely arose independently as a polyploid derivative of two other species, *Avena hirtula* and *Avena wiestii* (Alicchio et al. 1995*,* Garcia et al. 1991, Katsiotis 1997, Ladizinksky *1995). Avena fatua,* a close relative of A. *sativa* (cultivated oat), may have evolved in response to early cultivation, first as a crop, and later coincident with cereal production (Hjelmquist 1955, Lindsay 1956*,* Sexsmith 1967). Darmency and Aujas (1992) found genetic variation for growth rates and competitive ability in *A. fatua.*

Geographic distribution. A native of Europe, slender wild oat has been introduced into western North America, southern Africa, and South America (Arnold and de Wet 1993, Arnow 1987, Gibbs Russell et al. 1955*,* Holmgren and Holmgren 1977, Montenegro et al. 1991, Munz 1959, Romero Zarco 1996). However, the related Eurasian *A. fatua,* has been introduced and has become naturalized , in addition to the above, in Australia, New Zealand, Hawaii and Japan (Chapman 1991, Holm et al. 1977, Ohwi 1965, Wagner et al. 1990, Webb et al. 1988).

Avena barbata was first reported from California by Vasey (1885), although it probably had become widespread much earlier (Robbins 1940). *Avena barbata* was probably introduced into California more than once during the 18th century. However, recent studies suggest that nearly all naturalized California strains are most closely related to those found in southwestern Spain (de la Vega 1991, Garcia et al. 1989). Cluster and Allard (1995) and Rai (1985) also provided evidence showing that significant ecotypic differentiation may have taken place in California within the last 150-200 generations (perhaps less than 150-200 years). *Avena fatua* also was well established before the end of the 18th century (Hendry and Bellue 1925, Robbins 1940).

Both species have been reported from all northern California Channel Islands and Santa Barbara Island (Junak et al. 1997) and are widespread in most California counties west of the Great Basin and deserts (Anonymous 1998, Wilken 1993).

Reproductive and vegetative biology. Both *Avena barbata* and *A. fatua* are self-compatible and strongly selfing (Clegg and Allard 1972, Imam and Allard 1965), despite their dependency on wind-pollination. Populations in California show considerable ecological differentiation with respect to allozymes (Hamrick and Allard 1972). Both *Avena barbata* and *A. fatua* are characterized by considerable genetic variation (e.g., Jain 1969, Jain and Marshall 1970, Jain and Rai 1974, Jain et al. 1981, Marshall and Jain 1969), including such traits as growth rates, seed dormancy, and germination responses (Somersalo et al. 1988, Thurston 1963). *Avena fatua* shows a broad range of response to regional climates, including the ability to flower and produce seeds at any time of the year in subtropical climates (Jain 1969, Thurston 1959, 1963). Persistence in cultivated fields may also depend on variation in seed dormancy and germiantion responses (Banting 1996).

Seeds of A. *fatua* generally germinate in the late fall and early winter, depending on soil moisture, in warm and cool temperate climates (Fernandez-Quinantilla et al. 1990). Germination rates of fresh seeds can exceed 50% under most temperate conditions, leading to immediate recruitment following the first seasonal rains (Fernandez-Quinantilla et al. 1990, Thurston 1962). However, seeds can remain dormant or undergo secondary dormancy, especially under cold conditions (Fregeau and Burrows 1989, Sawhney 1989). Dormancy is generally broken by a combination of moisture and relatively warm (20˚ to 40˚ C) soil conditions (Foley 1994). Although seeds buried as deep as 20 cm can germinate and produce viable seedlings, buried seeds may remain dormant from 4 to 7 years, unless exposed by deep cultivation and short-days, followed by relatively warm, moist conditions (Conn 1990, Hilton 1985, Hilton and Bitterli 1983, Johnston et al. 1994, Miller and Nalewaja 1990, Thurston 1961, 1962).

Plants grow relatively rapidly in Europe, with flowering and fruiting dependent on soil nutrients, density of associated species, and the extent of spring rains (Cousens et al. 1992). In California oak *(Quercus agrifolia)* savanna, *Avena fatua* is generally restricted to open sunny sites, displaying reduced growth and lower competitive ability under shade (Maranon and Bartolome 1993). Hobbs (1986) provided evidence that over the long-term, *Avena* and other annual grassland species are slowly replaced by coastal sage scrub under some conditions. Although plants of *A. barbata* show reduced fruit production under drought conditions, the mean fruit weight remained relatively uniform (Ewing and Menke 1983a, 1983b). In California, natural populations of *Avena fatua* can have strong allelopathic effects (Tinnin and Muller 1971a, 1971b). Under experimental conditions, root exudates of A. *fatua* are allelopathic to several different crop seeds (Perez and Ormeno-Nunez 1991).

Ecological distribution. Both *Avena barbata* and *A. fatua* occur in dry cultivated fields, roadsides, waste places, formerly tilled fields, and grazed pastures, although the latter species tends to be restricted to disturbed or formerly tilled sites (Arnow 1987, Baum et al. 1972, Holmgren and Holmgren 1977, Munz 1959, Rocha Afonso 1980, Wilken 1993, Stromberg and Griffin 1996)

Weed status. *Avena barbata* is not considered a noxious weed in agricultural or horticultural practice, at least at a global level (not listed by Holm et al. 1977), nor is it considered a noxious weed by the State Dept. of Food and Agriculture (Anonymous 1996). It is not listed for the United States in Lorenzi and Jeffery (1987). In contrast, *A. fatua* is one of the most widespread and serious weeds of the world, primarily in cultivated cereal crops (Holm et al.1977, Lindsay 1956, Lorenzi and Jeffery 1987), probably as a result of its widespread cultivation for grain and later as a hay crop for over 2,000 years (Hjelmquist 1955, Jessen and Helbaek 1945, Coffman 1961).

Microbial pathogens. *Avena* species can serve as hosts to dwarf mosaic viruses, but infections in *Avena fatua* and *A. sativa* were not found to be virulent (Achon et al. 1996). Smut and mildew fungi *(Ustilago aveneae, Erysiphe graminis)* have been reported from *Avena barbata* and *A. fatua* (Nielsen 1993, Sabri et al. 1997, Sabri and Clarke 1996). *Avena barbata* includes strains both susceptible and resistant to infection by *Puccinia* rust fungi (Karow et al. 1997, Katsiotis and Forsberg 1995). Both *Avena fatua* and *A. sativa* are hosts to *Puccinia coronata* and *P. graminis,* which often cause significant damage to plants under cultivation in Canada (Chong 1988, 1990, Chuang and Harder 1991, Chong and Seaman 1989, 1990, Harder 1989, Harder and Dale 1990, Kolmer and Chong 1993). Douglas et al. (1996, 1997) summarized and evaluated a program that used *Puccinia coronata* as a biocontrol of *Avena barbata* on San Clemente Island.

Avena barbata growth may be enhanced by mycorrhizal infection (Rillig et al. 1998). Infection by mycorrhizal fungi *(Glomus etunicatum, G. intraradices)* enhanced growth of *Avena fatua* in cultivated fields of *Avena sativa.* (Koide et al. 1988, Koide and Lu 1992, Lu and Koide 1991).

Insect pathogens. No literature was found that reported insects detrimental to *Avena barbata* or *A. fatua,* although the latter has been reported as a incidental host to Mirid bugs *(Calocoris norvegicus)* infesting pistacios (Purcell and Welter 1990).

Herbicide control. Price et al. (1988) described the use of barban and difenzoquat in controlling *Avena barbata.*. Numerous studies have evaluated the use of several herbicides in controlling *A. fatua,* including chlorsulfuron, diclofop-methyl, dipenzoquat, flamprop-methyl, fluazifop, glyphosate, haloxyfop, metribuzin, quizalofop, sethoxydim, 2,4-D, and triallate (Chow 1988, Donald 1990, Eberlein et al. 1988, Friesen 1988, Harker and O'Sullivan 1988, Jam and van den Born 1989, Kafiz et al. 1989, Kirkland et al.1989, Kudsk 1988, Martin et al. 1989, Miller 1990, Morrison 1990, Thai et al. 1989, Warkintin et al. 1988). Nietschke (1996) and Nietschke and Medd (1996) provided general reviews on control of*Avena fatua* in cultivated crops.

Combinations of flurtamone and ethalfiuralin was shown to be more effective against *A. fatua* than either alone (Blackshaw et al. 1992). Harker et al (1995) reported successful treatment of *Avena fatua* with ethametsulfuron when mixed with sethoxydim, but other combinations (with haloxyfop, fluazifop, and quizalofop) caused significant injury to the associated dicot crop (canola). Wall (1994) found mixtures of fluazifop and clethodim effective in controlling annual grasses, including *Avena,* in flax fields. Wells (1989) reported enhanced effect of glyphosate treatments using adjuvants in control of *Avena fatua.*. Grayson et al. (1995) and Murphy et al. (1995) reported similar results with flamprop-m-isopropyl. Ammonium sulfate increased the efficacy of sethoxydim in experimental plants of *Avena fatua* (Smith and Vanden Born 1992). Ahrens and Ehr (1991) reported enhanced efficacy of atrazine-cyanazine mixtures when plants of *Avena fatua* were treated with tridiphane. Sodium bisulfate enhanced the effect of imazamethabenz in controlling *Avena fatua* (Liu et al 1995). Xie et al. (1994, 1997) reported effective control of *Avena fatua* using mixtures of imazamethabenz and fenoxaprop under drought conditions.

In contrast, Jensen and Caseley (1990) reported antagonistic effects of 2,4-D amine and bentazone with tralkoxydim in attempts to control *Avena fatua.* Eberlein, et al. (1988) studied anatgonistic combinations of herbicides, showing that, in some cases, thiameturon interfered significantly with diclofop control of *Avena fatua.*

Strains of *Avena fatua* resistant to atrazine, diclofop, triallate, cyclohexanedione, and aryloxyphenoxypropionate have been reported by Powles and Stewart (1990), Devine et al. (1992), Joseph et al. (1990), Morrison and Devine (1995), and Seefeldt et al. 1994). Kibite et al. (1995) studied inheritance of genes conferring resistance to diclofop and fenoxaprop -p-ethyl in *Avena sativa* x *A. fatua* hybrids. However, strains resistant to triallate were susceptible to and could be controlled by atrazine, ethalfiuralin, fenoxaprop-P, flamprop, imazamethabenz, and tralkoxydim (Blackshaw et al. 1996). Thill et al. (1994) evaluated and discussed Integrated weed management strategies for delaying the evolution of herbicide resistance in *Avena fatua.*

Other control methods. The use of organic mulches enhanced the competitive ability of outplanted *Artemisia californica* over *Avena fatua* in potential coastal sage scrub communities (Zink and Allen 1998).

Literature Cited

Achon, M., M. Pinner, V. Medina, and G. Lomonossoff. 1996. Biological characteristics of maize dwarf mosaic potyvirus from Spain. European Journal of Plant Pathology. 102: 697-705.

Ahrens, W. and R. Ehr. 1991. Tridiphane enhances wild oat *(Avena fatua)* control by atrazine-cyanazine mixtures. Weed Technology. 5: 799-804.

Alicchio, R., L. Aranci, and L. Conte. 1995. Restriction fragment length polymorphism based on phylogenetic analysis of *Avena* L. Genome. 38:1279-1284.

Anonymous. 1996. Exotic pest plants of greatest ecological concern in California as of August 1996. California Exotic Pest Plant Council. 8 pp.

Anonymous. 1998. California county flora database version 2, Santa Barbara Botanic Garden and USDA National Plants Data Center, Santa Barbara and New Orleans. URL = plants.usda.gov

Arnold, T. and B. de Wet. 1993. Memoir 62. Plants of southern Africa: names and distribution. National Botanical Institute, Pretoria. 825 pp.

Arnow, L. 1987. Gramineae. pp.684-788. In Welsh et al. A Utah Flora. Great Basin Naturalist Memoirs 9:1-894.

Banting, J. 1966. Factors affecting the persistence of *Avena fatua*. Canadian Journal of Plant Science. 46: 469-478.

Baum, B., G. Fleischmann, J. Martens, T. Rajhathy, and H. Thomas. 1972. Notes on the habitat and distribution of *Avena* species in the Mediterranean and Middle East. Canadian Journal of Botany 50: 1385-1397.

Blackshaw, R., R. Morrison, H. Henning Muendel, and B. Roth. 1992. Weed control in safflower *(Carthamus tinctorius)* with flurtamone. Weed Science. 40:110-114.

Blackshaw, R., J. ODonovan, M. Sharma, K. Harker, and D. Maurice. 1996. Response of triallate-resistant wild oat *(Avena fatua)* to alternative herbicides. Weed Technology. 10: 258- 262.

Chapman, A. 1991. Australian plan name index. A-C. Australian Governinent Publishing Service, Canberra. 897 pp.

Chong, J. 1988. Virulence and distribution of *Puccinia coronata* in Canada in 1986. Canadian Journal of Plant Pathology. 10: 237-278.

Chong, J. 1990. Occurrence and virulence of oat crown rust in Manitoba in 1989. Canadian Plant Disease Survey. 70: 44-45.

Chong, J. and D. Harder. 1991. Occurrence of oat rusts in western Canada in 1990. Canadian Plant Disease Survey. 71: 70.

Chong, J. and W. Seaman. 1989. Virulence and distribution of *Puccinia coronata* in Canada in 1988. Canadian Journal of Plant Pathology. 11: 439-442.

Chong, J. and W. Seaman. 1990. Distribution and virulence of *Puccinia coronata* in Canada in 1989. Canadian Journal of Plant Pathology. 12: 431-435.

Chow, P.1988. Effect of chlorsulfuron on four graminicides for weed control and wheat yield. Weed Research. 28:145-150.

Clegg, M. and R. Allard. 1972. Patterns of genetic differentiation in the slender wild oat species *Avena barbata.* Proceedings, National Academy of Sciences. 69:1820-1824.

Cluster, P. and R. Allard. 1995. Evolution of ribosomal DNA (rDNA) genetic structure in colonial Californian populations of *Avena barbata.* Genetics. 139: 941-954.

Coffman, F. 1961. Oats and oat improvement. American Society of Agronomy, Madison Wisconsin. 650 pp.

Conn, J.S. 1990. Seed viability and dormancy of 17 weed species afier burial for 4.7 years in Alaska. Weed Science. 38:134-138.

Cousens, R., S. Weaver, J. Porter, J. Rooney, D. Butler, and M. Johnson. 1992. Growth and development of *Avena fatua* (Wild-oat) in the field. Annals of Applied Biology. 120: 339-351.

Darmency, H. and C. Aujas. 1992. Genetic diversity for competitive and reproductive ability in wild oats *(Avena fatua).* Weed Science. 40: 215-219.

de al Vega, M., P. Garcia, and R. Allard. 1991. Multilocus genetic structure of ancestral Spanish and colonial Californian populations of *Avena barbata.* Proceedings of the National Academy of Sciences of the United States of America. 88:1202-1206.

Devine, M., S. MacIsaac, M. Romano, and J. Hall. 1992. Investigation of the mechanism of diclofop resistance in two biotypes of *Avena fatua.* Pesticide Biochemistry and Physiology. 42: 88-96.

Donald, W. 1990. Difenzoquat. Monograph Series, Weed Science Society of America. 6: 289-320.

Douglas, L., P. Reeves, J. Stone, C. Winchell, M. Johnson, K. Leonard, and D. Sands. 1996.

Puccinia coronata, a possible biocontrol agent of *Avena* spp. on San Clemente Island. Phytopathology (abstract). 86 (Supplement): 15.

Douglas, L., L. Carsten, M. Johnston, and D. Sands. 1997. Evaluation of *Puccinia coronata* as a biocontrol agent of wild oats on San Clemente Island. (abstract). Phytopathology. 87 (Supplement): 25

Eberlein, C., T. Miller, and J. Wiersema. 1988. Influence of thiameturon and DLX-L5300 on wild oats (*Avena fatua*) control with barban, diclofop, AC 222,293, and difenzoquat. Weed Science. 36: 792-799.

Ewing, A. and J. Menke. 1983a. Reproductive potential of *Bromus mollis* and *Avena barbata* under drought conditions. Madrono 30: 159-167.

Ewing, A. and J. Menke. 1983b. Response of soft chess (*Bromus mollis*) and slender oat (*Avena barbata*) to a simulated drought cycle. Journal of Range Management 36: 415-418.

Fernandez-Quinantilla, C., J. Gonzalez Andujar, and A. Appleby. 1990. Characterization of the germination and emergence response to temperature and soil moisture of *Avena fatua* and *A. sterilis.* Weed Research. 30: 289-295.

Foley, M. 1994. Temperature and water status of seed affect afierripening in wild oat *(Avena fatua).* Weed Science. 42: 200-204.

Fregeau, J. and V. Burrows. 1989. Secondary dormancy in dormoats following temperature treatments: field and laboratory responses. Canadian Journal of Plant Science. 69: 93-99.

Friesen, G. 1988. Annul grass control in flax *(Linum usitatissimum)* with quizalofop. Weed Technology. 2:144-146.

Garcia, P., F. Vences, M. Perez de la Vega, and K. Allard. 1989. Allelic and genotypic composition of ancestral Spanish and colonial Californian gene pools of *Avena barbata:* evolutionary implications. Genetics. 122: 687-694.

Garcia, P., M. Morris, L. Saenz-de-Meira, K. Allard, M. de la Vega, and G. Ladizinksy. 1991. Genetic diversity and adaptedness in tetraploid *Avena barbata* and its diploid ancestors *Avena hirtula* and *Avena wiestii.* Proceedings of the National Academy of Sciences of the United States of America. 88:1207-1211.

Gibbs Russell, G., L. Watson, M. Koekemore, L. Smook, N. Barker, H. Anderson, and M. Dallwitz. *1955.* Grasses of southern Africa. Memoirs of the Botanical Survey of South Africa No.58.437 pp.

Grayson, B., S. Boyd, and D. Walter 1995. Reinvestigating adjuvants for the Wild Oat Herbicide, Flamprop-M-Isopropyl I: Glasshouse Trials. Pesticide Science. 43:147-155.

Hamrick, J. and R. Allard. 1972. Microgeographical variation in allozyme frequencies in *Avena barbata.* Proceedings, National Academy of Sciences. 69: 2100-2104.

Harder, D. 1989. Incidence and virulence of *Puccinia gram mis* f. sp. *avenae* in Canada in 1988. Canadian journal of plant pathology. 11: 435-438.

Harder, D. and M. Dale. 1990. Incidence and virulence of *Puccinia graminis* f. sp. *avenae* in Canada in 1989. Canadian journal of plant pathology. 12: 436-438.

Harker, K. and P.O' Sullivan. 1988. Ammonium sulphate enhances control of annual grass weeds in canola *(Brassica campestris)* with sethoxydim. Canadian Journal of Plant Science. 68:1087-1093.

Harker, K., K. Blackshaw, and K. Kirkland. 1995. Bthametsulfuron interactions with grass herbicides on canola *(Brassica napus, B. rapa).* Weed Technology. 9: 91-98.

Hendry, G. and M. Bellue. 1925. The plant content of adobe bricks. California Historical Society Quarterly 4: 361-373.

Hilton, J. 1985. The influence of light and potassium nitrate on the dormancy and germination of *Avena fatua* L. (wild oat) seed stored buried under natural conditions. Journal of Experimental Botany 36: 974-979.

Hilton, J. and C. Bitterli. 1983. The influence of light on the germination of *Avena fatua* L. (wild oat) seed and its ecological significance. New Phytologist 95: 325-333.

Hitchcock, A. Poaceae. pp.103-255. In Abrams, L. Illustrated flora of the Pacific States. 1. Ophioglossaceae to Aristolochiaceae, Stanford University Press, Stanford, California. 538 pp.
Hjelmquist, H. *1955.* The oldest history of cultivated plants in Sweden. Opera Botanica 1:168-180.
Hobbs, E. 1986. Characterizing the boundary between California annual grassland and coastal sage scrub with differential profiles. Vegetatio 65: 115-126.
Holm, L., D. Plucknett, J. Pancho, and J. Herberger. 1977. The world's worst weeds: distribution and ecology. University Press of Hawaii, Honolulu. 609 pp.
Holmgren, A. and N. Holmgren. 1977. Poaceae. pp.175-462. In Cronquist et al. Intermountain Flora. Volume 6. The monocotyledons. New York Botanical Garden and Columbia University Press, New York. 584 p.
Imam, A. and R. Allard. 1965. Population studies in predominantly self-pollinated species. VI. Genetic variability between and within natural populations of wild oats, *Avena fatua* L., from differing habitats in California. Genetics 51: 49-62.
Jain, S. 1969. Comparative ecogenetics of two *Avena* species occurring in central California. Evolutionary Biology 3: 73-118.
Jain, S. and D. Marshall. 1967. Population studies in predominantly self-pollinated species. X. Variation in natural populations of *Avena fatua* and *Avena barbata*. American Naturalist 101: 19-33.
Jain, S. and K. Rai. 1974. Population biology of *Avena*. IV. Polymorphism in small populations of *A. fatua*. Theoretical and Applied Genetics 44: 7-11.
Jain, S., K. Rai, and R. Singh. 1981. Population biology of *Avena*. XI. Variation in peripheral isolates of *A. barbata*. Genetica 56: 213-215.
Jam, K. and W. van den Born. 1989. Morphological and histological effects of three grass selective herbicides on developing wild oat *(Avena fatua).* Weed Science. 37: *575-584.*
Jensen, K. and J. Caseley. 1990. Antagonistic effects of 2,4-D amine and bentazone on control of *Avena fatua* with tralkoxydim. Weed Research. 30: 389-395.
Jesson, K. and H. Helbaek. 1945. Creals in Great Britan and Ireland in prehistoric and early historic times. Biologiske Skrifier 3:1-68.
Johnston, M., G. Fernadez, and A. Olivares. 1994. Capacidad germinativa en especies de la pradera anual mediterranea. II. Efecto del ano de produccion de semillas. Phyton. *55: 59-69.*
Joseph, 0., S. Hobbs, and S. Jana. 1990. Diclofop resistance in wild oat *(Avena fatua).* Weed Science. 38: 475-479.
Junak, S., S. Chaney, R. Philbrick, and R. Clark. 1997. A checklist of vascular plants of Channel Islands National Park. Southwest Parks and Monuments Association, Tucson, AZ. 43 pp.
Kafiz, B., J. Caussanel, J., R. Scalla, and Gaillardon. 1989. Interaction between diclofop-methyl and 2,4-D in wild oat *(Avena fatua* L.) and cultivated oat *(Avena sativa* L.), and fate of diclofop-methyl in cultivated oat. Weed Research. 29: *299-305.*
Karow, R., K. McNamara, and R. Forsberg. 1987. Crown rust resistance in progeny from a derived tetraploid X natural tetraploid cross in *Avena*. Genome. 29: 206-208.
Katsiotis, A. and R. Forsberg. 1995. Production and cytogenetics of tetraploid-octoploid *Avena* hybrids. Zeitschrift fur Pflanzenzuchtung. 114:137-143.
Katsiotis, A., M. Hagidimitriou, and J. Heslop-Harrison. 1997. The close relationship between the A and B genomes in *Avena* L. (Poaceae) determined by molecular cytogenetic analysis of total genomic, tandemly and dispersed repetitive DNA sequences. Annals of Botany. 79:103-109.
Kibite, S., K. Harker, and P. Brown. 1995. Inheritance of resistance to diclofop-methyl and fenoxaprop-p-ethyl in two *Avena sativa* x *A. fatua* populations. Canadian Journal of Plant Science. 75: 81-85.
Kirkland, K., K. Harker, and P. O'Sullivan. 1989. Influence of metribuzin and cyanazine on the

phytotoxicity of graminicides on wild oats and barley.. Canadian Journal of Plant Science. 69:195-203.

Koide, R., M. Li, J. Lewis, and C. Irby. 1988. Role of mycorrhizal infection in the growth and reproduction of wild vs. cultivated plants. I. Wild vs. cultivated oats. Oecologia. 77: 537-543.

Koide, R. and X. Lu. 1992. Mycorrhizal infection of wild oats: maternal effects on offspring growth and reproduction. Oecologia. 90: 218-226.

Kolmer, J. and J. Chong. 1993. Distribution of virulence in two populations of *Puccinia coronata* f.sp. *avenae* in Canada. Canadian Journal of Botany. 71: 946-950.

Kudsk, P.1988. The influence of volume rates on the activity of glyphosate and difenzoquat assessed by a parallel-line assay technique. Pesticide Science. 24: 21-29.

Ladizinsky, G. 1995. Characterization of the missing diploid progenitors of the common oat. Genetic Resources and Crop Evolution. 42: 49-55.

Lindsay, D. 1956. Taxonomic and genetic studies of wild oats *(Avena fatua).* Weeds 4: 1-10.

Liu, S., A. Hsiao, W. Quick, T. Wol{ and J. Hume. 1995. Effect of sodium bisulfate on the phytotoxicity, retention, foliar uptake, and translocation of imazamethabenz on wild oats (*Avena fatua* L.). Weed Science. 43: 40-46.

Lorenzi, H. and L. Jeffery. 1987. Weeds of the United States and their control. Van Nostrand Company, New York. 355 pp.

Lu, X. and T, Koide. 1991. *Avena fatua* L. seed and seedling nutrient dynamics as influenced by mycorrhizal infection of the maternal generation. Plant, Cell and Environment. 14: 931-939.

Maranon, T. and J. Bartolome. 1993. Reciprocal transplants of herbaceous communities between *Quercus agrjfr)lia* woodland and adjacent grassland. The Journal of Ecology. 81: 673-682.

Marshall, D. and S. Jain. 1969. Genetic polymorphism in natural populations of *Avena fatua* and *A. barbata*. Nature 221: 276-278.

Martin, R., W. Felton, and A. Somervaille. 1989. A comparison of tri-allate formulations for control of wild oats in wheat in northern New South Wales. Australian Journal of Experimental Agriculture. 29: 215-221.

Miller, S.. 1990. Triallate. Monograph Series, Weed Science Society of America. 6: 266-280.

Miller, S. and J. Nalewaja. 1990. Influence of burial depth on wild oats *(Avena fatua)* seed longevity. Weed Technology 4: 514-517.

Morrison, 1.1990. Flamprop-methyl. Monograph Series, Weed Science Society of America. 6: 346-358.

Morrison, I. and M. Devine. 1994. Herbicide resistance in the Canadian prairie provinces: Five years after the fact. Phytoprotection. 75: 5-16.

Munz, P.1959. A flora of California. University of California Press, Berkeley. 1681 pp.

Murphy, M., M. Craven, and B. Grayson. 1995. Reinvestigating adjuvants for the wild oat herbicide, flamprop-m-isopropyl. II: Field performance. Pesticide Science. 43: 157-162.

Nielsen, J. 1993. Host specificity of *Ustilago-Avenae* and *Ustilago-Hordei* on eight species of *Avena.* Canadian Journal of Plant Pathology. 15:14-16.

Nietschke, B. 1996. Cultural weed management of wild oats. Plant Protection Quarterly. 11:187-189.

Nietschke, B. and R. Medd. 1996. Chemical weed management of wild oat. Plant Protection Quarterly. 11:190-192.

Ohwi, J. 1965. Flora of Japan. Smithsonian Institution, Washington D.C. 1066 pp.

Perez, F. and J. Ormeno-Nunez. 1991. Root exudates of wild oats: allelopathic effect on spring wheat. Phytochemistry. 30: 2199-2202.

Powles, S. and P. Stewart. 1990. Herbicide-resistant weeds in Australia. Weed Technology. 4:178-185.

Price, S., J. Hill, and R. Allard. 1988. The morphological and physiological response of slender oat (*Avena barbata*) to the herbicides barban and difenzoquat. Weed Science. 36: 60-69.

Purcell, M. and S. Welter. 1990. Seasonal phenology and biology of *Calocoris norvegicus* (Hemiptera: Miridae) in pistachios and associated host plants. Journal of Economic Entomology. 83:1841 - 1846.

Rai, K. 1985. Regional patterns of polymorphisms in natural populations of *Avena barbata.* Canadian Journal of Genetics and Cytology. 27: 639-643.

Rillig, M., M. Allen, J. Kilronomos, N. Chiariello, and C. Field. 1998. Plant species-specific changes in root-inhabiting fungi in a California annual grassland: Responses to elevated CO-2 and nutrients. Oecologia. 113: 252-259.

Robbins, W. 1940. Alien plants growing without cultivation in California. Agricultural Experiment Station. Bulletin 637. University of California, Berkeley. 128 pp.

Rocho Afonso, M. 1980. *Avena.* pp.206-208. In Tutin et al. (eds). Flora Europaea. Volume 5. Alismataceae to Orchidaceae. Cambridge University Press, Cambridge. *452* pp.

Romero Zarco, C. 1996. Synopsis of the genus *Avena* L. (Poaceae, Aveneae) in peninsular Spain and the Balearic Islands. Lagascalia. 18:171-198.

Sabri, N. and D. Clarke. 1996. The relative tolerances of wild and cultivated oats to infection by *Eiysiphe graminis* f. sp. *avenae*: I. The effects of infection on vegetation growth and yield. Physiological and Molecular Plant Pathology. 49: 405-421.

Sabri, N., P. Dominy, and D. Clarke. 1997. The relative tolerances of wild and cultivated oats to infection by *Erysiohe graminis* f. sp. *avenae*: II. The effects of infection on photosynthesis and respiration. Physiological and Molecular Plant Pathology. 50: 321-335.

Sawhney, R. 1989. Temperature control of dormancy and germination in embryos isolated from seeds of dormant and nondormant lines of wild oats (*Avena fatua*). Canadian Journal of Botany. 67:128-134.

Seefeldt, S., D. Gealy, B. Brewster, and E. Fuerst. 1994. Cross-resistance of several diclofop-resistant wild oat *(Avena fatua)* biotypes from the Willamette Valley of Oregon. Weed Science. 42: 430-437.

Sexsmith, J. 1967. Varietal differences in seed dormancy of wild oats. Weed Science. 15: 252-255.

Sexsmith, J. 1969. Dormancy of wild oat seed under various temperature and moisture conditions. Weed Science. 17: 405-407.

Smith, A. and W. Vanden Born. 1992. Ammonium sulfate increases efficacy of sethoxydim through increased absorption and translocation. Weed Science. 40: 351-358.

Somersalo, S., P. Makela, A. Rajala, E. Nevo, and P. Peltonen-Sainio. 1998. Morpho physiological traits characterizing environmental adaptation of *Avena barbata.* Euphytica. 99: 213-220.

Stromberg, M. and J. Griffin. 1996. Long-term patterns in coastal California grasslands in relation to cultivation, gophers, and grazing. Ecological Applications. 6:1189-1211.

Thai, K., S. Jana, and L. Fowke. 1989. Cell membrane permeability and ultrastructural effects of difenzoquat on wild oats *(Avena fatua).* Weed Science. 37: 98-106.

Thill, D., J. O'Donovan, and C. Mallory-Smith. 1994. Integrated weed management strategies for delaying herbicide resistance in wild oats. Phytoprotection. 75: 61-70.

Thurston, J. 1959. A comparative study of the growth of wild oats (*Avena fatua* and *Avena ludoviciana*) and of cultivated cereals with varied nitrogen supply. Annals of Applied Biology. 47: 716-739.

Thurston, J. 1960. Dormancy in weed seeds. pp.69-82. In J. Harper. (ed.) The biology of weeds. Blackwell Scientific Publications, Oxford, Great Britain. *256* pp.

Thurston, J. 1961. The effect of burying and frequency of cultivation on survival and germination of seeds of wild oats (*Avena fatua* L. and *A. ludoviciana* Dur.). Weed Research 1:19-31.

Thurston, J. 1962. An international experiment on the effect of age and storage conditions on viability and dormancy of *Avena fatua* seeds. Weed Research 2:122-129.

Thurston, J. 1963. Biology and control of wild oats. pp. 235-253. In Annual Report. Rothamsted Experiment Station, Harpenden, England. 316 pp.

Tinnin, R. and C. Muller. 1971a. The allelopathic potential of *Avena fatua*: influence on herb distribution. Bulletin, Torrey Botanical Club. 99: 243-250.

Tinnin, R. and C. Muller. 1971b. The allelopathic potential of *Avena fatua*: the allelopathic mechanism. Bulletin, Torrey Botanical Club. 99: 287-292.

Vasey, G. 1885. Descriptive catalog of grasses of the United States. USDA, Government Printing Office, Washington D.C. 56 pp.

Wagner, W., D. Herbst, and S. Sohmer. 1990. Manual of the flowering plants of Hawaii. 1853 pp.

Wall, D. 1994. Fluazifop-p tank-mixtures with clethodim for annual grass control in flax *(Linum usitatissimum).* Weed Technology. 8: 673-678.

Warkentin, T., G. Marshall, R. McKenzie, and I. Morrison. 1988. Diclofop-methyl tolerance in cultivated oats (*Avena sativa* L.). Weed Research. 28: 27-35.

Webb, C., W. Sykes, and P. Garnock-Jones. 1988. Flora of New Zealand. Volume 4. Naturalized pteridophytes, gymnosperms, dicotyledons. Department of Scientific and Industrial Research, Christchurch. 1365 pp.

Wells, A.. 1989. Adjuvants, glyphosate efficacy and post-spraying rainfall. Plant Protection Quarterly. 4:158-164.

Wilken, D. 1993. *Avena.* pp. 1235-1236. In Hickman, J. (ed.). The Jepson manual: vascular plants of California. University of California Press, Berkeley. 1400 pp.

Xie, S., W. Quick, and A. Hsiao. 1994. Effect of drought and formulation on wild oat (*Avena fatua*) control with imazamethabenz and fenoxaprop. Crop Protection. 13: 195-200.

Xie, H., A. Hsiao, and W. Quick. 1997. Influence of drought on graminicide phytotoxicity in wild oat (*Avena fatua*) grown under different temperature and humidity conditions. Journal of Plant Growth Regulation. 16: 233-237.

Zink, T. and M. Allen. 1998. The effects of organic amendments on the restoration of a disturbed coastal sage scrub habitat. Restoration Ecology. 6: 52-58.